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Duluth, Minnesota Solid Waste/Sewage Sludge Co-Disposal Project

Brown, Vence and Associates
San Francisco, CA

Prepared for

California State Solid Waste Management Board
Sacramento

Jun 81

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DULUTH, MINNESOTA

SOLID WASTE/SEWAGE SLUDGE CO-DISPOSAL PROJECT

TECHNICAL BULLETIN

June, 1981

Prepared for:

STATE SOLID WASTE MANAGEMENT BOARD
State of California - The Resources Agency
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This technical bulletin is one of a series of reports presenting information gathered in visits to resource recovery facilities around the United States. This study effort has been sponsored by the California State Solid Waste Management Board (CSSWMB). As a number of California resource recovery facilities approach the implementation stage, the CSSWMB has recognized the need to learn from existing projects. In later 1980, five states were chosen and visited by staff members from Brown, Vence and Associates, consultants to the CSSWMB. These sites included both small and large scale facilities, a number of differing technologies, and projects in varying stages of implementation or operation. The subject of this technical bulletin is the Duluth, Minnesota, solid waste/sewage sludge co-disposal project.

KEYWORDS: *Solid waste disposal, *Sludge disposal, *Solid waste management, *Waste recycling, *Refuse derived fuels, *Sewage sludge, *Duluth(Minnesota).

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PREFACE

This technical bulletin is one of a series of reports presenting information gathered in visits to resource recovery facilities around the United States. This study effort has been sponsored by the California State Solid Waste Management Board (CSSWMB). As a number of California resource recovery facilities approach the implementation stage, the CSSWMB has recognized the need to learn from existing projects. In later 1980, five states were chosen and visited by staff members from Brown, Vence and Associates, consultants to the CSSWMB. These sites included both small and large scale facilities, a number of differing technologies, and projects in varying stages of implementation or operation. The five sites were:

- Auburn, Maine
- Duluth, Minnesota
- Madison, Wisconsin
- Saugus, Massachusetts
- Akron, Ohio

The subject of this technical bulletin is the Duluth, Minnesota, solid waste/sewage sludge co-disposal project.

TABLE OF CONTENTS

INTRODUCTION 1

CHAPTER 1 - PROJECT ORIGIN

IDENTIFICATION OF NEED 4
KEY PARTICIPANTS 4
CHRONOLOGY 5
FEDERAL, STATE, AND LOCAL REGULATIONS AND PERMITS.. 6

CHAPTER 2 - PROJECT DESCRIPTION

LOCATION AND WASTESHED 8
TYPE OF SYSTEM 8
PLANT DESIGN RATES 8
ACTUAL PLANT RATES 10
PHYSICAL PLANT AND STAFF 11

CHAPTER 3 - PROJECT FINANCES AND RISK ALLOCATION

METHOD OF FINANCE 17
FINANCIAL PERFORMANCE 17
PROCUREMENT 20
RISK ALLOCATION 20

CHAPTER 4 - PROJECT EVOLUTION

PLANT RELIABILITY 21
MODIFICATIONS 21
IMPACT ASSESSMENT AND COMPLIANCE 24
SUCCESSES, FAILURES, REMEDIES 24
FUTURE DEVELOPMENTS 25

CHAPTER 5 - THE CALIFORNIA PERSPECTIVE

INTRODUCTION 27
PROJECT LOCATION 27
ASH DISPOSAL 27
AIR POLLUTION 27
WASTEWATER 28
STATE SOLID WASTE MANAGEMENT AGENCY 28
PERMIT PROCESS 28
OTHER CONSIDERATIONS 29

CHAPTER 6 - PROJECT EVAULATION

PROJECT BENEFITS 31
PROJECT-RELATED PROBLEMS 31
UNEXPLOITED OPPORTUNITIES 31
HINDSIGHT EVALUATION 31

APPENDIX A - FIELD INSPECTION NOTES 32

APPENDIX B - BIBLIOGRAPHY 42

LIST OF TABLES

i-1	PROJECT FACT SUMMARY	3
1-1	PROJECT CHRONOLOGY	6
2-1	CITIES AND TOWNSHIPS SERVED BY CODISPOSAL PLANT	9
3-1	FUNDABLE PROJECT COSTS AND SOURCES OF FUNDS	18
3-2	CONSTRUCTION COSTS, AS BID	19

LIST OF FIGURES

i-1	THE WESTERN LAKE SUPERIOR SANITARY DISTRICT	2
2-1	SITE PLAN	12
2-2	SOLID WASTE PROCESSING FLOW DIAGRAM	13
2-3	AIR CLASSIFIER/SECONDARY SHREDDER	14
2-4	RDF/SLUDGE CODISPOSAL FLOW DIAGRAM	15
4-1	SHREDDER FEED AND PIT CONVEYORS	22

INTRODUCTION

In Duluth, Minnesota, the Western Lake Superior Sanitary District (WLSSD) is shaking down the nation's first facility utilizing fluidized bed reactors to co-dispose sewage sludge and municipal solid waste (MSW). Construction of the co-disposal facility was substantially completed in early 1980, and an extensive test of the plant was run in June of that year. A number of operating problems have been identified and solutions to those problems are being developed.

The WLSSD plant, designed by Consoer Townsend and Associates of Chicago, is expected to co-dispose approximately 300 tons per day (TPD_7)* of dewatered sewage sludge and 300 to 400 TPD_5** of MSW from the greater Duluth area. Figure i-1 shows the area served by the WLSSD. The MSW first will be processed into a refuse-derived fuel (RDF), then burned with sludge in fluidized bed reactors. In these reactors, stable, efficient combustion is promoted by beds of sand suspended and kept fluid by a combination of powerful blowers and high temperatures. Waste heat boilers will produce steam for in-plant use and, possibly, for sale to nearby users. Wet scrubbers will provide air emissions control.

The WLSSD co-disposal project evolved from the District's concern about the price and availability of fuel oil for a proposed sludge incinerator. In 1974, the Minnesota legislature extended the District's jurisdiction to include disposal of all solid waste produced within its boundaries; the District's subsequent development of a co-disposal facility followed naturally from its responsibility for and control over both solid waste and sludge disposal. Implementation of the project has been characterized by efficient planning and by the District's willingness to proceed patiently in shaking down a new technology. Several noteworthy features of the WLSSD project exemplify this careful development:

- The District commissioned Consoer Townsend to prepare a comparative study of five possible co-disposal technologies. District staff visited a variety of operational resource recovery facilities.
- WLSSD actively pursued, and successfully obtained, clean water grant monies for the solid waste processing portion of the project, as well as for the sludge disposal and wastewater treatment aspects. These grant funds have provided about 90% of the co-disposal project's $23 million capitalization.
- Near the plant, there are several potential markets for excess steam produced at the facility. The District has decided to refrain from contracting to sell steam until the plant is fully operational; this has meant that the shakedown period has not been constrained by a steam delivery date.
- The District has secured about $2.4 million in additional funding to cover modifications that were identified as necessary during shakedown tests run in June, 1980. These changes include installation of equipment to reduce the content of fine noncombustibles in the RDF, extensive changes to conveyors and pneumatics handling raw waste and RDF, and the replacement of a wet ash handling system with a dry process. Further shakedown operations are planned for later this year.

Table i-1 summarizes important facts about the project.

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* seven days per week basis
** five day per week basis

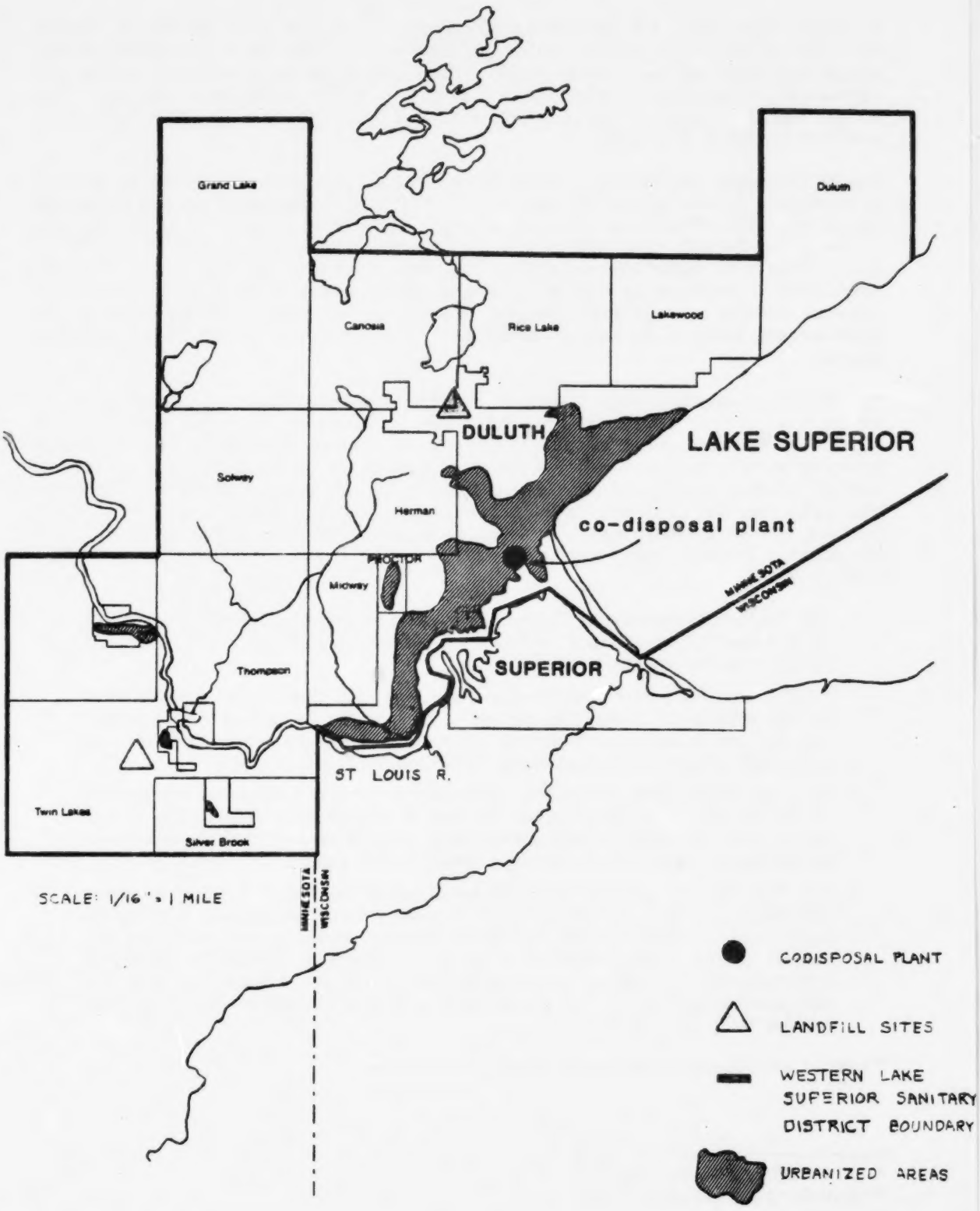

Figure i-1
THE WESTERN LAKE SUPERIOR SANITARY DISTRICT

Table i-1
FACT SUMMARY
FLUIDIZED BED SLUDGE/MSW CO-DISPOSAL PROJECT
DULUTH, MINNESOTA

Population served:	100,000
Shakedown began:	June, 1980
Principals:	Western Lake Superior Sanitary District - lead agency in planning, funding, construction, and operation of facility PRC Consoer Townsend - designer Minnesota Pollution Control Agency - funding approval, design evaluation, technical support, permitting
Volume:	refuse - 400 TPD, 5 days per week, 12 hours per day (design). sludge - 300 TPD dewatered sewage sludge (80% moisture), 7 days per week, 24 hours per day (design).
Technology:	Three-part system: 1) Wastewater treatment plant producing sewage sludge. 2) Refuse-derived fuel production using shredding, ferrous metal recovery, and air classification. 3) Co-combustion of dewatered sludge and RDF in fluidized bed reactors. Wet scrubbers for air emissions control.
Product:	Steam (saturated at 250°F) to 45,000 lb/hr from each of two boilers. Steam is used in-plant; in the future, some steam may be marketed.
Costs:	$23.3 million for RDF production and co-disposal, funded as follows: • $17.3 million USEPA Clean Water Grant • $3.5 million MPCA Wastewater Facility Grant • $2.5 million WLSSD internal funds Plant construction costs were $19.6 million, design $1.6 million, modification & shakedown $2.0 million. $2.4 million additional funding obtained for modifications ($1.7 million) and construction settlements ($680,000).
Revenues:	• Tipping fees of $3.30 per ton. • Ferrous metal sales. • Steam sales (potential).
Procurement:	Competitive bidding with no negotiations, architect/engineering approach.

CHAPTER 1 - PROJECT ORIGIN

IDENTIFICATION OF NEED

The Western Lake Superior Sanitary District was established by the State of Minnesota in 1971. Its principal responsibility was, and remains, the handling and treatment of wastewater from the greater Duluth area. As its advanced treatment facilities were designed, the District foresaw the need for a method to dispose of increased quantities of sludge. Lagooning of sludge had been attempted, but was found to be unacceptable, due to problems with odor and with lagoon operation and management. Landspreading was considered as an option, but the availability of land and the ease of management of a landspreading system were uncertain. Plans were developed for a multiple-hearth furnace sludge incinerator, to burn a mixture of dewatered sludge and fuel oil.

The oil embargo of 1973 and subsequent rapid increases in oil prices caused the District to reevaluate this plan. Both the high price of oil and the low priority of the District to receive allocated supplies posed potential problems. In 1974, the District's jurisdiction was increased to include solid waste. Subsequently, the District commissioned Consoer Townsend and Associates, the architects and engineers for the wastewater treatment plant, to prepare a study of solid waste/sludge co-disposal alternatives. Five alternative methods were studied:

1) Purox (vertical bed) pyrolysis and sludge drying
2) Landgard (rotary-kiln type) pyrolysis and sludge drying
3) Fluidized bed reactor and waste heat boiler
4) Steam boiler and sludge flash drying
5) Purox pyrolysis and multiple hearth incinerator.

The third alternative was found to have both the lowest cost and the highest "effectiveness," a rating based on nonmonetary factors including technical effectiveness and environmental impact. The fluidized bed system was thus established as the optimum solution to the District's need for a reliable source of energy for sludge disposal.

KEY PARTICIPANTS

Western Lake Superior Sanitary District

The District was created by the State in 1971, as noted above. In 1974, its powers and responsibilities were amended by the state legislature to include the disposal of all solid waste collected within its boundaries. A Board of Directors administers the District in accordance with its enabling legislation. The District has been the lead agency with respect to the planning, funding, construction and operation of this project.

The District is a powerful political entity. It is able to charge local governments for the cost of its activities, and it may levy property taxes as well. The District may condemn and purchase property where this is necessary for its operation. It may also designate the disposal sites to be used by any of the refuse haulers within its bounds. The District has aggressively pursued state and federal funding for all of its projects and activities.

PRC Consoer Townsend

This architectural and engineering firm, formerly known as Consoer Townsend and Associates, performed all design work for the wastewater treatment, solid waste

processing, and solid waste/sludge disposal facilities of the District. The firm has conducted several detailed studies to supplement the District's planning efforts in both wastewater treatment and solid waste disposal.

Minnesota Pollution Control Agency

This agency handles most environmental affairs for the State of Minnesota. Its Divisions of Water Quality, Air Quality, and Solid and Hazardous Waste have all been directly involved in the project. The Division of Water Quality approved state and federal funding, evaluated the design of the plant prior to bidding, approved the lowest bid for construction, tested effluent from the wastewater treatment plant, and provided technical support. Though not involved with the financing of the project, the Divisions of Solid and Hazardous Waste and Air Quality have carried out applicable regulatory duties, including the administration of air and solid waste permits.

Citizens' Advisory Committee

The Citizens' Advisory Committee was assembled by the District to provide a channel for public input regarding the project. Committee members included representatives from nearby communities, refuse haulers, scrap dealers and conservation groups. While this committee was not a major influence in design, construction or operation of the plant, WLSSD staff point out that the committee served as a "safety valve," providing a forum for the expression of citizen concern about political or environmental aspects of the project. In a region with relatively strong environment activism, the committee may have prevented delays due to confrontations with parties concerned about air or water pollution.

Potential Steam Markets

At such time as the District is able to sell excess steam, one or more of the potential steam markets will become a key participant. The Duluth Transit Authority bus garage, recently constructed within 1/4 mile of the project, is likely to be the prime candidate for steam sales. In anticipation of steam availability, they have designed their heating system for easy connection to an outside steam source.

A local iron works and a nearby post office are also candidate steam markets. The downtown steam heating loop has been investigated as a steam market, but its existing generating station (recently converted to burn Western coal) is approximately two miles from the solid waste facility, too far for a steam connection to be economical.

CHRONOLOGY

The order of events in the Duluth project has been relatively straightforward and similar to most grant-funded projects of its type. It differs from most waste-to-energy projects in that time was not required to seek either an energy market or major investors.

A significant break in events covering several months took place when the original subcontractor for the fluid-bed reactors went bankrupt and the performance bond company had to locate a substitute. Earlier in construction, a less severe delay had occurred when the pilings originally specified for the plant foundation were found to be too weak to withstand pile driving. The contractor had to switch to a pile with heavier sidewalls.

All in all, this project has proceeded without a sense of haste or crisis; a critical refuse disposal problem, which would increase the urgency of the project, does not exist. Also, landspreading, while expensive, is available as a sludge disposal alternative. Table 1-1 is a chronology of the Duluth project.

FEDERAL, STATE AND LOCAL REGULATIONS AND PERMITS

The National Pollutant Discharge Elimination System (NPDES) permit is the principal permit for this facility. This federal permit is administered by the Minnesota Pollution Control Agency (MPCA). The Duluth wastewater treatment plant received its NPDES permit on August 30, 1978. Subsequent visits to the facility have verified compliance with permit regulations. This permit does not specifically regulate the solid waste processing and sludge disposal functions of the plant. However, it does strictly regulate the quality of plant effluent, which in turn is affected by sludge disposal plant operations. Specifically, plant operators are concerned that the treatment of ash quench water by the plant may pose problems in adhering to NPDES requirements. A dry ash handling system is being designed (see Chapter 4, Modifications).

The MPCA issued a separate permit to construct the sewage treatment works, in early 1975. The agency also granted approval to construct and operate the sludge incineration (co-disposal) system. Additionally, a number of solid waste disposal permits relating to the facility have been issued by MPCA. Most of these give permission for landspreading of sludge at various locations near Duluth. To facilitate sludge handling at the plant, it has been necessary to stockpile sludge outdoors for brief periods; the permit for this activity was granted in May 1980.

Final operation of the facility will be permitted by the MPCA Division of Solid and Hazardous Waste, subject to Division approval for disposal of incinerator ash, other residues, and any excess sludge. This approval will be sought when the plant is fully operational; it will depend in part on results of leachate testing of residues and ash. The MPCA Division of Air Quality has not yet issued a permit to operate; this will not occur until the plant is fully operational and has been tested for compliance with respect to stack emissions.

On the local level, a building permit for the facility was processed by the City of Duluth in routine fashion, and a county solid waste permit was obtained for plant operation.

Table 1-1

CHRONOLOGY

Event	Date
Approval of enabling legislation forming WLSSD	May, 1971
Preliminary engineering report submitted	November, 1974
MPCA grants permission to construct and operate sludge incineration (co-disposal) facility	February, 1976
MPCA Board approves funding of co-disposal plant	February, 1976
MPCA makes grant offer to WLSSD	May, 1976
Bids received	July, 1976
Application to MPCA for solid waste processing facility	November, 1976
Bidder chosen for co-disposal plant construction	November, 1976
MPCA grants permit to construct and operate solid waste/resource recovery facility	December, 1976
Construction under way	December, 1976
Application for NPDES permit	January, 1978
Bankruptcy of fluidized bed reactor constructor	April, 1978
Envirotech hired as reactor constructor	July, 1978
NPDES permit granted	August, 1978
Ferrous metal contract obtained	July, 1978
Dryout of one reactor begun	September, 1979

CHAPTER 2 - PROJECT DESCRIPTION

LOCATION AND WASTESHED

Plant Location

Duluth is situated at the western tip of Lake Superior, at the border of Minnesota and Wisconsin. The WLSSD wastewater treatment plant is located on the lakeshore, south of the downtown area (Figure i-1). Treated effluent from the plant is discharged into Lake Superior. The wastewater plant serves a 500-square-mile area encompassing eight cities and ten townships, with metropolitan Duluth the largest source of both wastewater and solid waste. District boundaries are shown in Figure i-1.

Wasteshed

The cities and townships served by the District are listed in Table 2-1, and can be located in Figure i-1. The District covers portions of two counties; each county is presently served by a single landfill. The St. Louis County landfill is now owned by the District; the Carlton County landfill is privately-owned and operated. The St. Louis County landfill presently charges $1.10 per cubic yard, and its projected life is another 13 years. When fully operational, the codisposal plant will accept municipal solid waste generated by the St. Louis County portion of the District. As is apparent from Table 2-1, most of the waste for the plant originates in the City of Duluth. Residues from the co-disposal process will be landfilled at the existing St. Louis County site. Solid waste from Carlton County will continue to be landfilled.

All refuse collectors and haulers in the wasteshed are privately-owned companies. Legislation passed in 1974 gives solid waste authority to the District, within its boundaries; this includes the authority to designate the final disposal site for all collected refuse. The District thus has control of all waste needed by the processing plant.

TYPE OF SYSTEM

The WLSSD project has three parts: 1) wastewater treatment, 2) solid waste processing, and 3) codisposal of sewage sludge and solid waste. The latter two portions of the system are of primary interest here. In the solid waste processing facility, refuse from arriving packer trucks is pushed onto one of two pit conveyors by a front-end loader. Material is conveyed through primary shredding and magnetic separation processes; it is then air classified, and the light fraction is reshredded. The product of this secondary shredding is the refused dervied fuel (RDF). In the co-disposal plant, RDF is fed to two fluid-bed reactors, where it is burned together with dewatered sludge. Combustion of refuse supplies the heat necessary to dry and ignite the sludge. Alternatively, fuel oil may be burned instead of refuse. Exhaust gases from combustion pass through waste heat boilers, where saturated steam is generated at 250 psig for various in-plant uses. The primary use is for wastewater plant heating and air conditioning; also, some wastewater plant equipment is steam-driven, powered by steam from the co-disposal system. Up to 45,000 lb/hr of steam may be produced in each boiler. Wet scrubbers are utilized for air pollution control. Ash is disposed at the existing St. Louis County landfill, which was recently acquired by WLSSD.

PLANT DESIGN RATES

The three plant subsystems (wastewater treatment, RDF production, co-disposal) are somewhat independent of one another, and were designed to operate at differing rates, with storage capability between subsystems where necessary.

Table 2-1

CITIES AND TOWNSHIPS SUPPLYING MSW TO CO-DISPOSAL PLANT

Municipalities	% Contribution of MSW for Project
Cities	
Duluth	82.9
Proctor	2.8
Townships	
Canosia	1.0
Duluth	1.1
Grand Lake	1.1
Hermann	5.3
Lakewood	1.0
Midway	1.2
Rice Lake	2.6
Solway	1.0
	100.0

Processing Capacity

The solid waste processing plant was designed with near-total redundancy, including two primary shredder lines, each of which was designed to process up to 30 tons per hour (TPH) continuously. The maximum daily amount of solid waste expected to be processed through the plant is 400 TPD_5. Two operating shifts per day are allocated for solid waste processing, five days per week. Twelve hours will be needed each day for refuse processing and four for maintenance. When steady operation is achieved, the large RDF storage bin, an Atlas hopper with 700 tons design capacity, will hold sufficient RDF to allow burning around the clock and through the weekend.

Feed Material and Product Specifications

Feed material is municipal refuse, as collected, except that oversize bulky waste and hazardous materials are removed on the tipping floor. Plant designers have assumed that the intermediate product, RDF, has a heat value of approximately 5,500 BTU/lb.

The energy product is steam at 250 psig (saturated); as much as 45,000 lb/hr per boiler will be produced when full operation is attained. The District will use as much steam as possible within the plant. If an excess is produced, a market will be sought, and specifications will be developed at that time.

Ferrous metals are the only other product of the facility. Specifications in the Agreement for Sale of Ferrous Metals between WLSSD and Wisconsin Metal & Chemical Corporation (a detinner) require that contaminants be not more than 7% of any shipment in order for that shipment to be accepted. If tramp is 5% to 7%, the payment for the product is reduced by 10%.

Production Rates

As mentioned above, steam may be produced at rates up to 45,000 lb/hr in each of the two boilers. The designers estimate the production of ferrous metals to be 5,500 tons per year, which is about 1.5 tons per hour (10-hour day). This represents approximately 5% of the input refuse.

Residue Production

Two residues are produced by the Duluth plant: air classifed heavy fraction (36 TPD_5, design rate) and combustion ash (56 TPD_7, design rate).

ACTUAL PLANT RATES

The longest continuous run for the plant to date has been the five-day acceptance test performed in June 1980. WLSSD staff report that design rates of refuse and sludge processing were achieved throughout that test, but that overall plant performance was not satisfactory. Actual RDF heat value measurements ranged from 6,000 to 8,000 BTU/lb. RDF ash content was not measured. However, during the acceptance test, combustion ash production far exceeded the design specification, and plant personnel now estimate that its actual production rate will be about twice the design rate. Modification and shakedown have been scheduled for the latter part of 1981, after which time actual plant rates will be known.

PHYSICAL PLANT AND STAFF

Figure 2-1 shows a site plan for the facility. Note that most of the site is devoted to wastewater treatment. Area of the solid waste processing and disposal installations (Buildings 11 and 10, respectively), plus associated grounds and fuel storage area, is roughly $1\frac{1}{2}$ acres.

Materials Flow

RDF Production: Figure 2-2 is a detailed diagram of materials flow for the RDF production subsystem. Incoming truckloads of refuse are weighed on a remote-controlled electronic scale, then directed to a discharge point on the tipping floor.* A front-end loader scoops material into one of the two receiving pits. Pan conveyors move waste in each pit to a primary shredder, where refuse is milled to a nominal 4 inch particle size. Discharge from the two primary shredders is transferred by vibrating conveyors to a single belt conveyor for ferrous metal recovery, which is done by an overhead belt-type magnet. Nonmagnetics are divided (using a "pants-leg" chute) into two streams, each of which is fed to an air classifier/secondary shredder unit (see Figure 2-3). An air stream diverts light material into the shredder, while heavy material falls out in the noncombustibles fraction. The nominal size of secondary shredder product is $1\text{-}\frac{1}{2}$ inches. Some very light material remains in the air stream, bypassing the shredder; this is de-entrained in a cyclone and joins the shredder product (RDF). Meanwhile, the noncombustible heavies are scavenged for ferrous metal using a second overhead magnet; nonmagnetic heavies are loaded out in a transfer trailer, for hauling to landfill.

Co-disposal: From the secondary shredder, RDF may either be fed directly to the two fluidized bed reactors or conveyed to the storage bin. Figure 2-4 is a flow diagram of the co-disposal process. Rotating scrapers withdraw RDF from the bottom of the Atlas bin; RDF is then carried by a series of belt conveyors to an air lock. Pneumatic conveyors are used to feed RDF into the reactor vessels at a level below the surface of the fluidized bed. Dewatered sludge (80% moisture) is fed to the reactors continuously, with a cone-shaped deflector provided to distribute incoming sludge about the reactor bed. This is a modification from the original batch-fed dumping-door design.

In a reactor, the fluidized bed of sand is designed to promote efficient combustion by increasing mixing and by acting as a heat reservoir to maintain a high reactor temperature (1,400 to 1,600,F). The reactors are fitted with oil nozzles, so fuel oil can be used as an alternative fuel.

From each reactor, exhaust gases pass first through a large cyclone to de-entrain fly ash, then to a waste heat boiler where steam is produced. Following the boiler, a wet scrubber is used to remove pollutants; exhaust gas is then discharged to the atmosphere.

Sand is drawn off near the bottom of one side of the fluidized bed; makeup sand keeps the amount in the bed constant. Combustion ash is removed from the bottom of each reactor, then is water-quenched, thickened, and conveyed to loadout for hauling to the St. Louis county landfill.

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* The original design had called for trucks to discharge directly onto the pit conveyors; in practice, this was found to be unworkable as an even distribution of refuse on the pit conveyors was impossible to obtain.

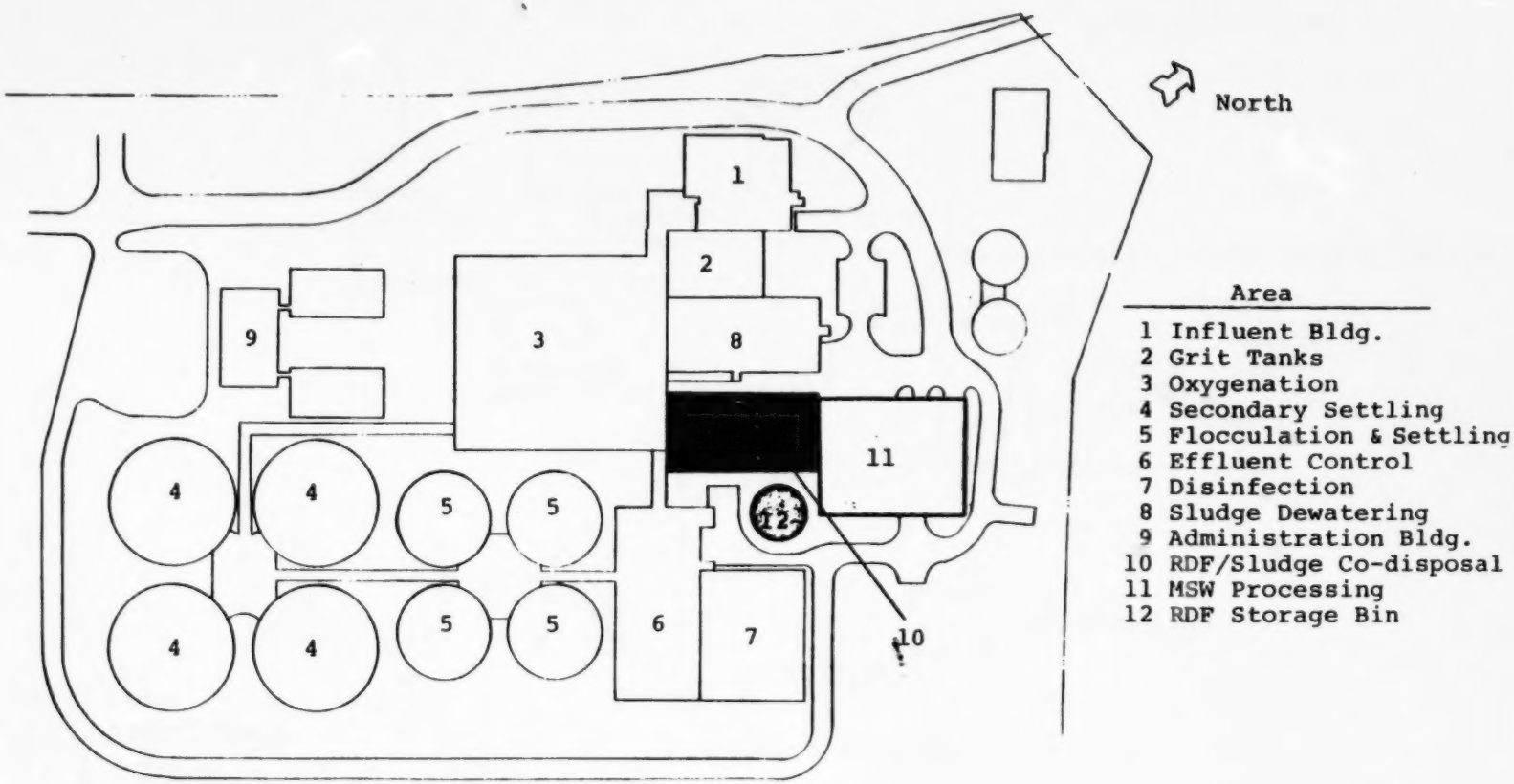
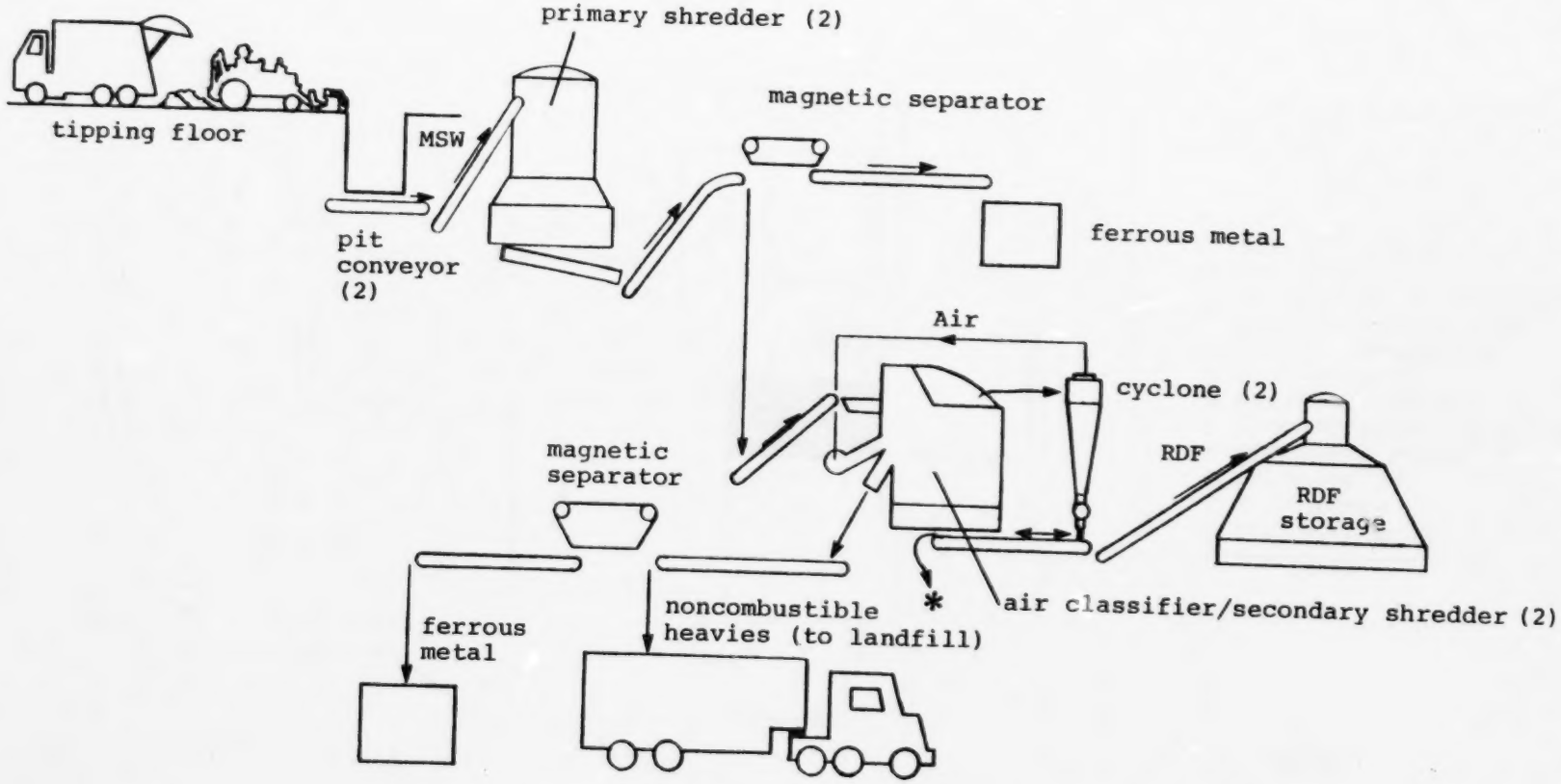


Figure 2-1

WLSSD CO- DISPOSAL PROJECT SITE PLAN



* RDF direct feed to reactors

Figure 2-2

SOLID WASTE PROCESSING FLOW DIAGRAM

(numbers in parentheses refer to the redundancy of equipment)

Figure 2-3

SECONDARY SHREDDER CUTAWAY SKETCH

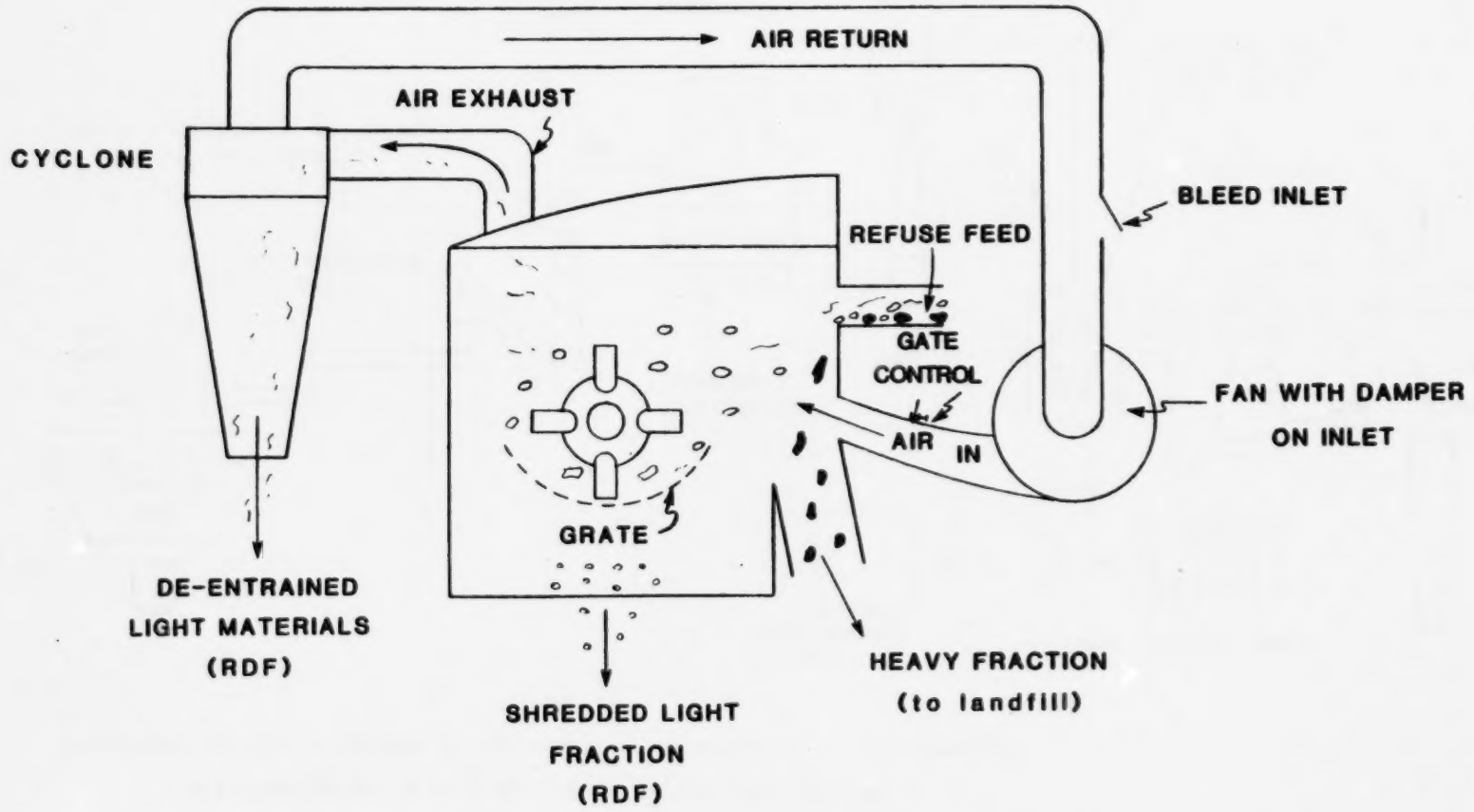
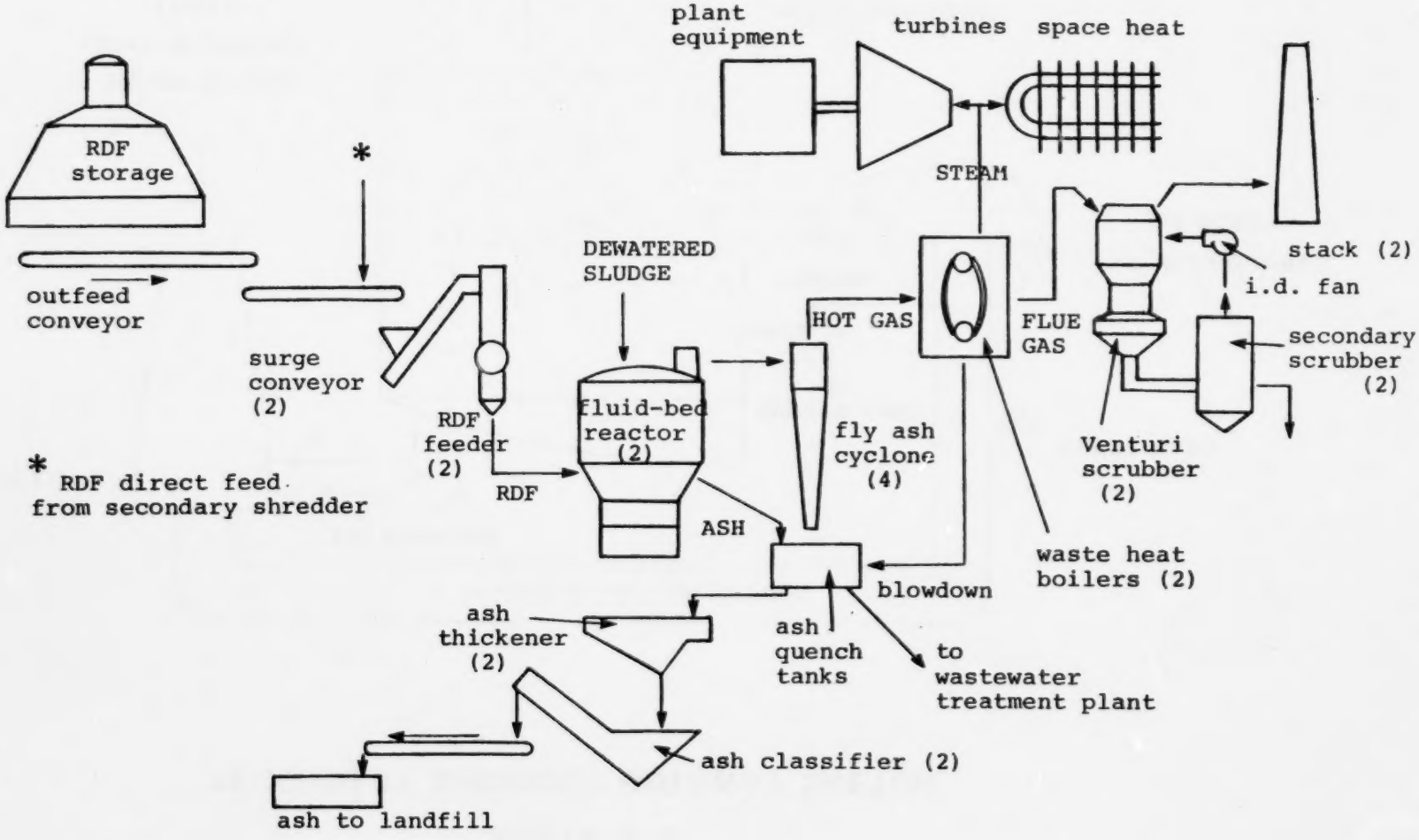


Figure 2-4

RDF/SLUDGE CO-DISPOSAL FLOW DIAGRAM

(numbers in parentheses refer to the redundancy of equipment)



Wastewater from the scrubber, the ash quench, and from other in-plant sources is treated at the adjacent sewage treatment plant, in same manner as plant influent.

Equipment Performance Specifications

Because the project had not yet been accepted by WLSSD when this report was prepared, technical specifications relating to equipment performance could not be made available. Basic design data relating to steam production, shredder performance, and ash production have been mentioned above.

Staffing

A crew of ten workers per shift is required for solid waste processing. This includes maintenance personnel. For solid waste/sludge combustion, an additional five or six workers per shift, including licensed boiler operators, are required.

CHAPTER 3 - PROJECT FINANCES AND RISK ALLOCATION

METHOD OF FINANCE

Approximately 90% of the $23 million original cost of the project (solid waste processing and sludge/RDF combustion) was funded by clean water grant monies. The balance was raised by WLSSD. The District issued a short-term general obligation bond in 1980 which listed the project to receive a portion of the proceeds. More detail is given in Table 3-1. An EPA clean water grant covered 75% of fundable costs; a Minnesota Pollution Control Agency (MPCA) clean water grant, another 15%; and the District, the remaining 10% plus certain items which were not eligible for grant support.

The District has the power to levy property taxes within its boundaries and can issue bonds as general obligations of the District. All bonds issued by the District are tax-exempt.

Construction costs for the solid waste processing and sludge/solid waste disposal facilities are broken out in Table 3-2. The slight discrepancy in total construction cost between this table and the previous one is due to minor cost adjustments between bidding and construction.

WLSSD is seeking additional funding. 1977 amendments to the Clean Water Act of 1972 allow 85% funding, rather than 75%, for innovative and alternative technologies. The District applied for this difference, and more, up to a total of $6 million. To date (March, 1981), about $2.4 million has been granted for additional construction ($1.7 million) and settlement costs ($680,000). Both MPCA and EPA have denied the WLSSD request for designation as an innovative facility, because WLSSD was awarded the original grant before the effective date of the Clean Water Act Amendments.

FINANCIAL PERFORMANCE

Actual financial performance of the facility will be established after debugging is completed and steady operation is attained. This may not occur until 1982, or perhaps even later. The District has not made a major effort to project costs and revenues throughout the project life, since there are no major financial obligations and there is no steam market per se. The District simply seeks to dispose of sludge by incineration rather than by the present method (landspreading), and with a minimal use of fuel oil. The following discussion is necessarily general.

Revenues

Tipping fees of $3.30 per ton will be charged to all haulers delivering to the plant. The District feels that this is equitable with the $1.10 per cubic yard charged at the county landfill.

The only other actual source of income is ferrous metal sales. The contract price of ferrous metal is $35 per long ton, subject to reduction for excessive contamination, as described in Chapter 2. Ferrous metal sales are expected to net approximately $100,000 per year, or about $1.00 per ton of received refuse, assuming 400 TPD_5 processed.

It is important to note the District's avoided cost of fuel oil which was projected for sludge incineration. Assuming RDF heat content of 5,500 BTU/lb (per design rate, actual values may be higher), RFD consumption of 160 TPD_7, 400 TPD_5 of solid waste processed, and #2 fuel oil (150,000 BTU/gallon) costing $40 per 42 gallon barrel, the value of the solid waste as a replacement fuel is over $40 per ton of recycled refuse.

Table 3-1

FUNDABLE PROJECT COSTS AND SOURCES OF FUNDS

Fundable Project Costs	
Construction and Implementation	$ 19,554,000
Architectural Engineering	990,568
Other Architectural	559,525
Contingency	1,955,307
TOTAL (fundable by EPA grant)	23,059,400
Sources of Funds	
Clean Water Grant, EPA, PL 92-500	17,294,500
MPCA wastewater facility grant	3,458,910
WLSSD funds	2,500,000
TOTAL	23,253,410

Table 3-2

CONSTRUCTION COSTS, AS BID

	Amount
Performance Bonds	300,000
Piling	1,401,000
Site Work	539,100
Concrete Framework	3,081,427
Masonry	409,685
Metals	559,713
Other Architectural	670,803
Conveying Systems	89,896
Mechanical	1,538,253
Electrical	1,173,901
Piping	965,482
Process Equipment	
Combustion System	3,818,750
Instrumentation & Controls	145,813
Ash Sluice & Removal	467,370
Ancillary Equipment	928,190
Materials Handling	3,188,327
Pumps	212,290
Erection, Testing Warranty	70,000
Total	19,560,000

The District also will avoid the expense of landspreading sludge, currently $49 per dry ton. Assuming 300 TPD_7 of sludge (80% moisture) consumed in the plant, the savings amount of approximately $10 per ton of received refuse.

Expenses

An early estimate of O&M costs, made in January 1976, is $1,386,000 per year. Assuming 400 TPD_5 refuse input, this equates to about $14 per ton of refuse received. Using 10% per year inflation through 1980, the 1981 O&M cost becomes $21.90 per ton or $2,232,000 per year. The District is exempt from property taxes.

PROCUREMENT

The District has followed a relatively standard procurement procedure. This was necessitated in part by the requirements of funding agencies that the lowest bidder be chosen from an open bidding process. Final design and a specifications package were prepared by the architectural and engineering firm and were used in soliciting bids from construction firms. A major local construction firm, Johnson Brothers Inc., together with several subcontractors submitted the lowest bid and were selected. It is noteworthy that the specifications for refuse processing equipment were performance-type, leaving some discretion to the equipment suppliers as to the type of machinery proposed. This also necessitated that a lengthy performance test (the five-day test of June 1980) be run prior to accepting the facility from the construction contractor.

RISK ALLOCATION

In this project, practically all risks are borne by the District.

Waste Supply: If the supply of refuse should be curtailed for any reason, the District must either use fuel oil in-place of refuse or landspread its sludge. Both of these options are less desirable than codisposal; the substitution of fuel oil, in particular, is much more expensive. This risk is minimized by the District's waste control authority.

Disposal of Residuals: The District bears this risk, and provides both the landfill site and the hauling service. If leachate from residuals, including ash, is determined to contain hazardous substances, then control of that leachate will be a District responsibility, with associated costs.

Facility Construction and Operation: Management of construction was provided by the design firm, Consoer Townsend & Associates. The principal contractor and all subcontractors were required to obtain performance bonding. When the plant was accepted by the District, all construction contractors were relieved of risk, and the District assumed the risk of correct operation of the facility. This acceptance was accompanied by a settlement of extraordinary costs among the various contractors and the District.

Facility Performance: In supplying grant funding for the project, both USEPA and MPCA have borne much of the risk that the facility will perform as designed. Of course, if performance is unsatisfactory, neither agency is directly penalized, but both will have spent large sums of public money with no improvement in sludge disposal practice. The risk that air emissions will exceed permitted quantities, requiring additional expense for pollution control equipment or process modifications, is borne by WLSSD.

CHAPTER 4 - PROJECT EVOLUTION

PLANT RELIABILITY

Since the plant is not yet operational, very little can be said regarding actual reliability or availability. The two reactors have been sized to each process more than half of the expected refuse fuel. However, if one reactor is shut down for maintenance, not all of the refuse can be put through the other reactor; it will be necessary to store some fuel and/or limit the amount of refuse received at the project.

Sufficient capacity and redundancy have been designed into the system so that, when performance reaches acceptable levels, sludge disposal may take place around the clock, 365 days per year. Unless environmental restrictions change, landspreading of sludge will continue to be available as a backup disposal method.

MODIFICATIONS

A number of modifications to the plant have been performed between the completion of construction and the present, and additional modifications are planned. District staff have identified five modifications which must be accomplished before attempting further operation of the system. Funding for these modifications, approximately $1.7 million of the $6 million grant request noted above, has been obtained. Some of these modifications have been completed, while others will require substantial design work prior to installation. They are:

1) install explosion venting in primary shredders (in process).
2) modify transfer points between conveyors to reduce jams (in process).
3) modify sludge feeding system from batch to continuous (done).
4) modify ash handling system to reduce phosphorus content of wastewater (in design).
5) modify pneumatic RDF feeders to reduce jams and wear (in design).

In the following discussion, completed modifications to solid waste processing equipment are treated first, followed by completed modifications to the co-disposal plant, and concluding with planned modifications.

Solid Waste Processing Modifications

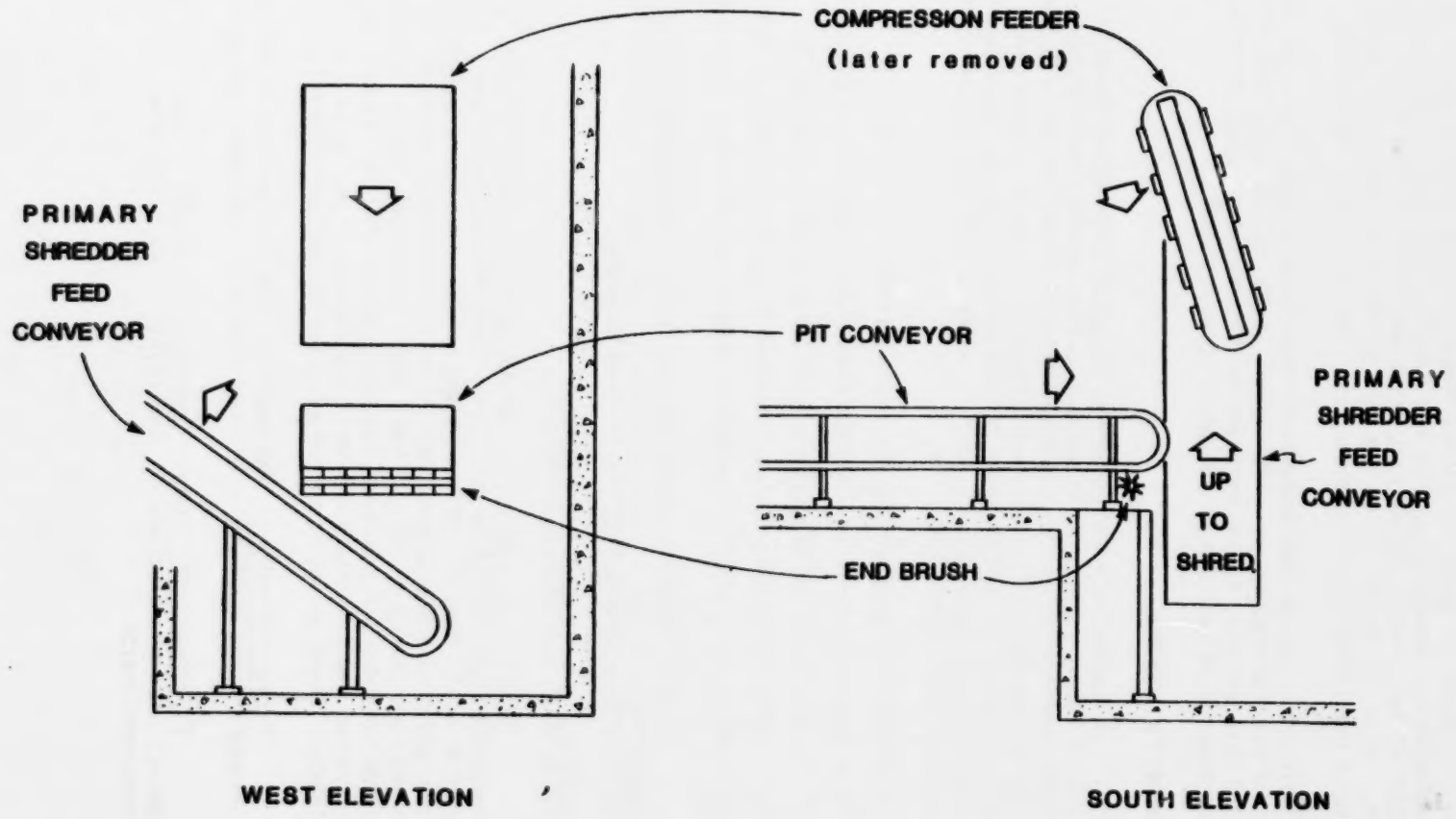
Raw Refuse Conveyors: In design of the plant, a series of cables were to be suspended over the refuse pits. These were to break up refuse as it was discharged from packer trucks directly into the pit and to reduce impact on the pit conveyor. In practice, the cables entangled a great deal of refuse; they were removed. Dust-suppression water sprays installed over the pits were found ineffective and were taken out of service. A large "inverted pan conveyor" had been located over the transfer point between each pit conveyor and its primary shredder feed conveyor (see Figure 4-1) to function as a burden leveler. These conveyors caused a number of jams and were removed.

Primary Shredders: The ballistics reject chutes have been blocked, and explosion venting is being installed. Additional blast mats have been hung around the shredders.

Ferrous Metal Product Conveyor: Originally a flight conveyor, it has been replaced with a belt conveyor. The flight conveyor was often jammed by tangles of the recovered metal.

Figure 4-1

PRIMARY SHREDDER FEED AND PIT CONVEYORS



Air Classifiers/Secondary Shredders: Dampers and gates controlling air flow into the classifier have been altered to improve performance.

Solid Waste/Sludge Disposal Modifications

Sludge Feed: The original dumping-door design for sludge feed to the fluid-bed reactor has been replaced by a continuous pumped-feed system; a deflector at the top of the reactor distributes the flow of sludge around the fluidized bed.

RDF Feed: The entry of the pneumatic RDF feed line into the reactor has been moved from above the bed to below the bed surface, to reduce fly ash carryover into the cyclones.

Ash Removal: The original sand tap ports were far too small to handle the actual flow of sand from the reactors. During the five-day acceptance test in June 1980, sand buildup occurred so rapidly that it was necessary to widen the sand tap ports, and to discharge sand into a wheeled cart which was manually hauled away and emptied. The cause of the problem seems to be a high content of fine noncombustibles (glass fragments, rock, dirt) in the RDF.

The ash quench, dewatering, and classification equipment systems were the site of numerous jams, breakdowns, and spillage; replacement with a dry ash handling system is underway. This modification is also in response to a problem with ash quench water seriously degrading the quality of treatment plant effluent.

Cyclones: The cyclones immediately downstream of the reactors became plugged with glass "clinkers" during testing. The cause of this problem seems to have been running the reactors at too high of a temperature (1,800°F and above). There have been no problems with the cyclones when the reactors have been operated at a somewhat lower temperature (1450-1500°F).

Future Modifications

Ash Reduction: The first priority for future major modifications is the installation of a trommel or disc screen in the solid waste processing line to reduce ash in the fuel. The general principle to be employed is to screen the material, separating fines (predominately non-combustibles, such as glass fragments, rock, dirt) from coarser material (primarily combustibles, such as paper, plastic, wood). The already-crowded equipment arrangement in the solid waste building will make this installation difficult. Tentative plans call for installation of a disc screen between the primary and secondary shredders, near the ferrous metal recovery magnet.

RDF Feed: The pneumatic feeders which convey RDF to the reactors have been targeted for modification, or perhaps replacement by a nonpneumatic system, to eliminate frequent plugging of ducts. The exact nature of this modification has not yet been determined.

Ash Handling: Similarly, it is recognized that some sort of modification will be needed for the ash handling system. The basic decision has been made to convert from a wet to a dry system, but the final design of that modification is not yet determined.

IMPACT ASSESSMENT AND COMPLIANCE

Air, water and solid waste impacts are each regulated by separate Divisions within the MPCA. The facility has not yet been tested for compliance with Minnesota air pollution control rules, primarily because the plant is still considered to be in shake-down. The facility must meet New Source Performance Standards for sludge disposal of 1.3 lb of particulates per dry ton of sludge and maximum opacity of 20%. The facility is also subject to the mercury emission standards of 40 CFR 61.50, which limit mercury emissions to 3200 gm/day. The Division of Air Quality has not specified further emission requirements.

The Division of Water Quality has visited the wasteshed treatment plant and sampled effluent; results were satisfactory. However, this sampling was performed while the solid waste/sludge combustion plant was not yet in operation. During combustion plant acceptance testing, it was found that the high phospherus content of ash quench water from solid waste/sludge disposal operations caused upsets within the wastewater treatment plant, resulting in excessive concentrations of ammonia in the treatment plant effluent. This was additional reason for the replacement of the wet ash handling system. Further monitoring is warranted and will no doubt take place.

The Division of Solid and Hazardous Waste has inspected the facility. When the solid waste/sludge disposal plant is operational, simulated leachate from samples of process residues will be tested using the Environmental Protection Agency's EP Toxicity Test. Test results will be used to determine appropriate disposal methods for these solids at the landfill.

SUCCESSES, FAILURES, REMEDIES

Grant Funding

The success which has been key to this project was the securing of clean water grant monies by WLSSD for the solid waste processing and solid waste/sludge co-disposal operations. This was not a simple matter. Grant applications are reviewed by MPCA technical staff and are then approved or denied by the governing board of MPCA. A certain percentage of clean water grant money is reserved each year for the Minneapolis/St. Paul metropolitan area, and the balance is available to the rest of the state. In 1975, when WLSSD applied for funding, they requested the full amount available outside the Twin Cities, effectively denying grant money to all other "out-state" applicants. Moreover, a large fraction of their grant request was for solid waste processing equipment and facilities; it was not directly related to wastewater treatment. Solid waste processing was seen by some MPCA staff as the sort of developmental risk for which R&D funding is more appropriate. For these reasons, MPCA staff recommended only partial funding of the WLSSD grant, eliminating funding for refuse processing. However, Board members took a broader view of the project and authorized the requested 90% funding of all aspects of the project, including refuse processing. This may be partially attributed to a concerted effort made by WLSSD staff to educate Board members about their proposal.

Adequate Planning

A hallmark of this project has been the consistently high level of effort devoted to planning by WLSSD. The planning effort has been remarkably efficient as well, with few diversions into fruitless areas of study. While no single staff member has "spearheaded" the project, WLSSD staff have functioned well as a team. The District began its solid

waste/sludge co-disposal work by gathering information on various sludge disposal methods and selecting the most appropriate one. Since that method required the use of solid waste, the District investigated waste quantities, compositions, and existing and planned means of solid waste disposal within its bounds. District staff were sent to visit various resource recovery facilities including Ames, Iowa; Appleton, Wisconsin; a fluid-bed combustion unit in Thunder Bay, Ontario; and several others. Preliminary design of the sludge/solid waste system was done, necessary refinements were made, grant funding was obtained, and final design and construction were performed. Concurrently, the privately-owned landfill serving the project area was condemned and purchased by the District, both to improve the quality of its operation and to ensure coordination with the co-disposal project.

Inexperience in Design

In 1974, no American engineering firm had a wealth of experience in resource recovery facility design. The Duluth solid waste processing plant contains a number of equipment configurations which would not be repeated by a designer having the benefit of experience between that time and the present. To name a few problems: the pit conveyor is eight feet deep; in most other facilities, pit conveyors are four feet deep or less. The feed conveyors to the primary shredders are quite steep ($37^{o}21'$). The discharge from both primary shredders is constricted to fall onto a single conveyor, then split to feed two secondary shredders; jams are frequent at these material transfer points.

Lack of experience with RDF production is also evident in the absence of certain unit processes from the system, notably a trommel or disc screen for removal of small noncombustibles.

Lowest-Bidder Requirement

For projects funded by clean-water grant money, it is a requirement that the lowest responsible bidder be accepted. Consideration of the contractor's capability to absorb financial setbacks does not pertain. This has been a hindrance to WLSSD in at least one instance, i.e., the bankruptcy of the reactor system subcontractor.

FUTURE DEVELOPMENTS

Additional Funding: The District has applied to the US EPA for $6 million in additional funding. About $2.4 million has been granted; $1.7 million of these funds will be used to perform needed design work and modifications.

Planned Modifications: A number of design and operating problems exist within the solid waste processing and solid waste/sludge disposal buildings. Many of these can be solved by modifying existing equipment; a few will require installation of additional or replacement machinery. These changes have been discussed in detail in the Modifications section of this chapter. The overriding need is to remove glass and other noncombustibles (mostly fine particles) from the fuel, and to correct problems with conveyors and feeders of raw waste and RDF. It appears that a trommel or disc screen is needed in the refuse processing side of the plant to reduce effectively the ash content of the fuel. Otherwise, separation equipment (magnet, air classifier) has been found to work satisfactorily.

Final Permitting: When the solid waste/sludge disposal plant becomes fully operational, the MPCA will test both air emissions and residue/ash leachate for the presence of various contaminants. Air emissions criteria were mentioned above. Ash leachate will be tested for the presence of eight metallic elements, four pesticides, and two herbicides, per EPA's EP procedure. When these discharges conform with state regulations, the Division of Air Quality will issue a permit to operate and the Division of Solid and Hazardous Waste will modify the stipulations on its permit so as to allow continuous operation of the facility.

CHAPTER 5 - THE CALIFORNIA PERSPECTIVE

INTRODUCTION

In this chapter, the Duluth project is examined with respect to its viability as a resource recovery project in California. Particular attention is paid to the issues of ash disposal, wastewater, and air pollution, and to the permitting process.

PROJECT LOCATION

The City of Duluth, population 100,000, is located at the western tip of Lake Superior. Duluth has long been the site of industries having a close relationship to nearby natural resources, such as paper mills, iron mining, and shipping. The surrounding land is mainly used for farming, timber and recreation. Extreme winter cold and the presence of Lake Superior are the two principal geographic differences between the Duluth area and any part of California; there are few, if any, similarities.

The presence of the lake has served as a focus for the environmental concerns of Duluth area citizens. Several conservation organizations, including the Izaak Walton League and the Save Lake Superior Association, are active within the community. This political aspect may be the strongest likeness between the Duluth project and any similar project that might be proposed in California.

ASH DISPOSAL

Plans to dispose of ash from the co-disposal process at the county landfill have been approved by the MPCA, subject to several conditions. The method of disposal proposed by the District is similar to that for demolition waste, i.e., with cover soil applied once a week. MPCA will approve this method if leachate tests of the ash do not reveal the presence of hazardous substances. WLSSD operates the landfill, and has designed an area of it with a leachate collection and recirculation system; this area will receive project ash and residues. This portion of the landfill is probably the equivalent of a Class II-1 disposal site in California.

In California, by way of contrast, incinerator ash is considered a hazardous waste under existing regulations. It must be disposed in a Class I or approved Class II-1 landfill. If the Duluth project were to move to California and operate successfully, it would still face a difficult economic situation due to the high cost of ash disposal.

AIR POLLUTION

The Duluth co-disposal plant is located in a nonattainment area for particulates and for carbon monoxide. No formal offset requirement or New Source Review was imposed, as the application for a permit to install the plant was submitted before those regulations went into effect. The Air Quality Division of MPCA has issued an installation permit for the incinerators and air pollution control equipment.

If the same project were to be attempted in California today, considerably more air pollution control equipment would be needed. Recommendations of the California Air Resources Board (CARB), published in their report "Air Pollution Aspects of Resource Recovery" are the major cause of concern. The CARB finds that Best Available Control Technology should be required on resource recovery plants now proposed for construction in California; that BACT for particulates is a baghouse which limits emissions to 0.01 gr/dscf; for oxides of sulfur and acid gases, flue gas desulfurization systems with 90% efficiency; for oxides of nitrogen, selective catalytic devices or wet NO_x scrubbers (probable BACT; determination not yet final).

When the Duluth plant is operational, the MPCA Air Quality Division will require stack testing to verify compliance with emissions regulations. Minnesota requirements limit opacity to 20% and particulate emissions to 1.3 lb per ton of dry sludge for sludge incinerators.

WASTEWATER

Co-disposal plant wastewater is routed to the adjacent WLSSD treatment plant. The largest portion of this water originates from the wet scrubber system, with ash quench water comprising the next largest fraction. The ash quench water originates as boiler blowdown; other sources of wastewater are minor. During co-disposal plant testing, the high phosphorus content of the ash quench water (20 to 60 mg/l) caused upsets within the treatment plant, resulting in excessive concentrations of ammonia in treatment plant effluent.

Although discharge regulations differ from state to state and between different regions within a state, the problems experienced in Duluth would certainly cause violations of California discharge limitations. For a similar project in California, it might be necessary to treat quench water prior to sewerage or dispose of it at a hazardous waste site. This should be considered during plant design.

STATE SOLID WASTE MANAGEMENT AGENCY

The MPCA is an "umbrella" agency, with Air Quality, Water Quality and Solid and Hazardous Waste Divisions. The Solid and Hazardous Waste Division's role is regulatory in nature. The MPCA granted a permit for construction of the co-disposal plant; it will permit plant operation if the Solid Waste Division approves WLSSD methods for storage and disposal of ash, residues, and excess sludge.

The role of the California State Solid Waste Management Board (SSWMB) in a Duluth-type project would have been different from that which was actually played by the MPCA. The SSWMB is authorized to provide funds for the various study phases of project development. Additionally, some money might be made available for specific equipment purchase, if so the SSWMB can provide important support of the developing project at critical stages. The Board would also make available, as possible, technical assistance.

The SSWMB is also, however, a regulatory agency amd as such would be directly involved in the project's permitting process. The Board permits all solid waste handling or processing facilities. As part of this permit the proposed facility must be in conformance with the local (County) solid waste management plan. The SSWMB must find the facility in conformance prior to issuing a facilities permit. Thus, the SSWMB serves as both a regulatory agency and a resource recovery/supporting agency.

PERMIT PROCESS

There are fewer state regulatory agencies in Minnesota than in California, and Minnesota's permitting requirements are simpler. It is likely that a project similar to WLSSD's, if built in California, would experience a more complex permitting process. In Duluth, one WLSSD staff member wrote practically all of the permit applications; this was not a primary part of his duties. The six permits are listed in Appendix A. Most of the permit submittal work was required in a period of several months prior to construction. The first permit application was submitted in 1972, and some permits (air emissions, for one) have not yet been issued. For such a project to take place in

California, coordination with the State Solid Waste Management Board, Air Resources Board, regional and state water quality control board(s), local air quality management district, and other state and local agencies would probably require the full-time attention of at least one professional for the period between design and approval of the plant.

OTHER CONSIDERATIONS

Local Citizen Use: As designed, the Duluth solid waste processing plant is not accessible to the public for personal disposal of refuse. Individuals with a truckload of refuse must drive to the county landfill. It is intended that this practice be continued, for two reasons. First, this avoids potential safety problems on the plant tipping floor. Second, WLSSD staff wish to avoid processing of oversize waste, white goods (appliances, etc.) and other difficult materials more likely to be brought to the plant by individuals than by collection vehicles. A similar policy probably could be instituted for a similar project in California, provided that citizens were already making use of the local landfill and that adequate landfill capacity was available.

Financing: To obtain clean water grant funding for a similar project in California, the project proponents would apply through the State Water Resources Control Board. Sludge disposal projects are considered on a case-by-case basis and are generally eligible for funding when sludge disposal is an integral part of facility operation. The funding of solid waste processing facilities would also be determined on an individual case basis.

Federal and state grant monies commonly account for 90% of design and construction costs; the remaining 10% must be raised by the grant applicant. The District provided the necessary 10% funding from their existing budget. This method would of course work in California as well, provided the applicant's budget was sufficiently large. However, a second option open to the District, the issuance of G.O. bonds, has not been open to public agencies in California since the passage of Proposition 13. An alternative for a California project would be issuance of tax-exempt revenue bonds; a necessary prerequisite would be a source of revenue to the facility, through tipping fees or sale of energy and/or solid residues.

California Co-Disposal Project: An investigation has been underway in western Contra Costa County into converting sewage sludge and refuse to usable energy. If feasible, the project would replace the demand for electricity produced by oil and natural gas-fired equipment, and furnish a new supply of steam power.

The concept originated from the intent of the West Contra Costa Sanitary District (WCCSD) to seek lower cost electricity for its wastewater treatment plant and less expensive sludge disposal. After an initial study in 1978, the West County Agency of Contra Costa County (WCA) assumed sponsorship of the project. The WCA is a joint powers agency of the WCCSD and the City of Richmond Municipal Sewer District.

The WCA has received two government grants to undertake the detailed feasibility study of the project. A Step I Clean Water Grant was funded by the State Water Resources Control Board. It is supplemented by a grant from the Resource Recovery Program administered by the State Solid Waste Management Board.

Waste Composition: Two seasonal variations in the Duluth waste stream may or may not be duplicated in California, depending on location. The first is a seasonal variation in yard waste, which peaks in the spring. The second is an increase due to tourism, which reaches a maximum in mid-summer. The effects of these variations in quantity and composition on the co-disposal plant's performance are as yet unknown, but design of the plant took into account a gradual increase in waste quantity.

Waste Control: WLSSD has control of the waste within its boundaries, assuring a steady supply to the plant when needed. This control was granted by the State in an amendment to the District's enabling legislation.

In California, the issue is not clear-cut. City and county ordinances and franchise agreements with collectors differ in the amount of control of the waste that is assigned to the collector/hauler or to local government. A consistent policy over a large population base would be necessary to guarantee waste flow to a similar project.

California state law does not prohibit local or regional waste control regulations. Moreover, a portion of the Solid Waste Management and Resource Recovery Act of 1972, Government Code 66780.8, states:

> "(wastes) shall be specifically commited as necessary to the project, for the life of the bonded indebtedness of the project or until such time as the project permanently ceases to operate, whichever occurs first."

In addition, the Attorney General of the State of California has concluded that solid waste is subject to police power regulation, and such regulation does not constitute a taking violative of the Fifth Amendment. In an opinion dated October 8, 1976, the Attorney General further concluded that such regulation would not constitute an impairment of contract in the event that private waste haulers had city contracts relating to waste collection, so long as the regulation constituted a reasonable exercise of the police power serving the public health and safety, and did not primarily benefit private interests.

CHAPTER 6 - PROJECT EVALUATION

PROJECT BENEFITS

This co-disposal project provides several benefits to the Duluth area. Two traditionally troublesome wastes are disposed at a single facility. The WLSSD avoids the cost of fuel oil, and this savings is passed on to its taxpayers. The life of the county landfill is extended from 13 years to more than 20 years, and landspreading of sludge is avoided.

PROJECT RELATED PROBLEMS

A number of technical difficulties being experienced in this plant are the result of the presence of glass and other noncombustibles in the refuse-derived fuel. A simple means of eliminating these noncombustibles would be to install a trommel prior to the primary shredder; alternatively, disc screens could be used to remove fine particles after primary shredding. Either alternative would be difficult to install due to a general lack of space within the facility. However, many operating problems could be mitigated with this approach.

A further unresolved technical problem is the high phosphorus content of combustion plant wastewater. This may require "pretreatment" within the plant.

A potential problem is disposal of ash. If ash leachate is found to contain hazardous substances, then the necessary leachate control measures will add to project expense.

UNEXPLOITED OPPORTUNITIES

The Duluth system may be able to provide steam to a customer in the vicinity of the co-disposal plant. WLSSD has taken a cautious approach to energy marketing; they will first get the system running, then assess the amount of excess steam produced, then seek a market for that steam. This strategy has worked in their benefit as shakedown time has been extended, since the District is not obligated to meet a deadline for steam delivery.

HINDSIGHT EVALUATION

In speaking with various participants in this project, the question was raised, "If the project were to begin again, what would you do differently?" Few of the participants could offer concrete suggestions; most were reasonably satisfied with the project as it exists. The need for better communication with local governments and citizens was stressed by one WLSSD staff member. It was also emphasized that the numerous technical and operating problems experienced during start-up were not the fault of the designer; when the co-disposal plant was designed, very little experience in the processing of municipal solid waste was available to any designer. Moreover. the architecture and engineering firm was selected when the sludge disposal concept was incineration with oil, prior to redesign for co-disposal. WLSSD staff noted several design changes in addition to those stated in Chapter 4, Modifications. Primary shredding should have taken place in a separate building, for safety reasons; pit depth should have been minimized; and separation of noncombustibles (e.g., by trommel) should have been installed prior to any shredding.

APPENDIX A - FIELD INSPECTION NOTES

GENERAL QUESTIONS

Background: What was the problem that provided impetus?

Need for sludge disposal method that consumes minimal fossil fuel.

Benefits of the project?

Improved sludge disposal method (vs. landspreading, lagooning)
Increased landfill life
Improved management of landfill
Integrated waste disposal system for Duluth area

Does it solve the problem at hand?

Yes - when operating.

Does it cause any other problems?

Operating problems due to novel application of fluid-bed technology; debugging is needed.

Ash quench water causes upsets in sewage treatment plant.

If the same project were begun today, what would differ?

Design changes: less pneumatics; remove noncombustibles at front-end, and/or after primary shred; other materials handling changes (see report).

Planning: increased communication with citizens.

Role of State Solid Waste Agency?

Conditional permit to dispose of residues in landfill; inspection and permitting of facility.

State Water Quality agency approval of funding for 90% of design and construction costs.

Local governments - how cooperative?

Showed concern and interest, no substantial objection.

Waste Supply - how obtained?

District has waste control within its boundary, by law.

Unexploited opportunities for energy/material recovery?

Possible nearby steam markets: bus garage, foundry, post office. Must first ascertain amount of surplus steam produced.

Critical factors in development of the plant.

Obstacles:

Objection from MPCA Water Quality staff to funding as water pollution project, due to solid waste disposal aspect and new application of technology; citizen concern regarding environmental effects of project.

Boosts:

1974 state legislation adding waste disposal to WLSSD responsibilities, included waste control regulations; support of MPCA Board for EPA funding of solid waste processing.

PLANNING - STUDIES

1)	Preliminary Engineering Report, Wastewater Treatment and Collection Facilities, Phase I	Consoer, Townsend & Associates	July 1972
	Facility Report, Solid Waste System	Consoer, Townsend & Associates	April 1975
	Duluth-Superior Harbor Foreign Shipboard Waste Disposal Study	Consoer, Townsend & Associates	1977
	Solid Waste Management Plan	WLSSD	1977 Revision
	Preliminary Engineering Report, Solid Waste Disposal System	Consoer, Townsend & Associates	November 1977
	Energy Study - Generation, Conservation, Operations, Utilization	Consoer, Townsend & Associates	December 1978

2) Alternatives Investigated

Continued Landfill
Codisposal w/Sludge
Pyrolysis
RDF/Dedicated Boiler, Steam Drying of Sludge

3) Wastes Considered

Type	TPY	Avg. TPD	Min/Max (Seasonal Change)
Municipal	105,000	400 TPD_5	Winter, 320 TPD_5 Summer, 520 TPD_5

4) Technology Recommended: Codisposal, fluid-bed reactor

Reason: Judged highest in technical effectiveness and in benefit-to-cost ratio

5) Future Considerations

2-5 Years

Waste Increase: Minimal

Disposal Methods: Additional processing hours, if needed

5-15 Years

Waste Increase: 30% at most

Disposal Methods: Additional processing hours, seek steam market; landfill available, if needed

PLANNING - GENERAL

1) Risk Allocation

Type of Risk	Entity Assuming Risk	How Assumed
Waste Supply	WLSSD	Waste control legislation
Energy Markets	WLSSD	No market yet sought; steam used in-house
Disposal of Residuals	WLSSD	Operate landfill
Facility Construction	WLSSD; CT&A	Contracts with construction companies; performance bonds
Facility Operation	WLSSD	Hires, trains operating crew

2) Impetus

Disposal Problem - solid waste and (especially) sludge

3) Citizen Participation

Committees (formed or existing) - Solid Waste Advisory Committee, with representation of citizens, business, conservationists, and WLSSD.

Local government involvedment - Eight (8) cities plus ten (10) townships are within the District; all are represented on District Board.

Public Meetings: No., Sponsor, Purpose - Monthly meetings of Solid Waste Advisory Committee.

Citizen Complaints - None regarding plant operation. Citizen concern has been expressed over possible air pollution problems.

4) Recycling Programs - Prior, Existing and Planned

Existing: Duluth Sheltered Workshop - source separation, low tonnage.
Goodwill Industries - drop-off program, low tonnage.

No new programs planned.

5) Anticipated Efect of Recycling Program on Energy or Material Recovery

Negligible

6) Site Selection

Solid waste project located on wastewater treatment plant site. Original wastewater treatment plant also occupied this location.

OPERATION

1) Feedstock

Composition - "as-received"

Paper	40.2%	Ferrous	7.23%
Plastic	2.52%	Aluminum	0.50%
Textiles	1.72%	Glass	10.95%
Wood	2.59%	Other	2.72%
Rubber & Leather	0.65%		
Other Organics	30.70%		

Heat Value

4,650 BTU/lb.
(municipal waste)

6,000-8,000 BTU/lb.
(RDF)

2) Throughput

	Min.	Avg.	Max.
Design		30 TPH	60 TPH (surges only)
Actual	*	*	30 TPH

3) Energy Output (note variability) 90+% Availability (design value)

Steam: 45,000 lb/hr from each boiler, at: 250°F. saturated

4) Materials Outputs

	Flow Rate (TPH)	
Ferrous	Design	Actual
Ferrous metals	21 TPD_5	*

5) Residuals (indicate point of removal from process flow)

Type	Flow Rate	Distance to Disposal Point
Air classified noncombustibles	36 TPD_5	approx. 8 mi.
Reactor ash	107 TPD_7	"

6) Process Flow

See Figures 2-1 and 2-4

* Test period too brief to establish these values.

7) Modifications

	Description
Completed	sludge feed RDF feed to reactor moved to boiler sand level
Under way	explosion venting
Planned	ash handling (convert to dry) pneumatic RDF feed improvement

8) Maintenance

Requirement
annual boiler inspection
hammermill hammer hardfacing & replacement
periodic preventive maintenance of turbines & pumps

Note: Actual maintenance intervals have not yet been determined due to lack of operating time.

9) Traffic

	Mon-Fri	Sat & Sun
General Pub.	none	none
Collection	40 collection trucks per day	none

FINANCE

1) Project Initial Costs

See Table 3-2

2) Annual Operating Costs

Costs of waste processing and codisposal operation not available, due to lack of operating time.

3) Annual Revenues

Drop Charge: $3.30/ton

Ferrous Sales: $100,000/year

Wisconsin Metals, @$15 per long ton

4) Financing

See Table 3-1

5) Funds spent Prior to Award of Grant: Not available. Grant covered 90% of all design and construction costs, regardless of time incurred.

6) Procurement Process

Cost:	approx. $20 million
Procuring Entity:	WLSSD
Dates (From-To):	bids let immediately after grant offer, May 29, 1976 bids received July 1976 bidder chosen November 22, 1976

7) Acquisition Approach: Conventional

Reason for choice: Conventional approach (A&E design, subcontractor construct) is standard practice for WLSSD.

8) Tipping Fee

at landfill, prior to WLSSD ownership: $0.55/yd^3

at facility: $3.30/ton

at landfill, after WLSSD ownership: $1.10/yd^3

9) Method of Charging Disposal Cost to Users

Record net weights of collection trucks and bill periodically.

10) Waste Supply Agreements: District has waste control.

PERSONNEL

1) Operating Crew

Classification	No. (All Shifts)
refuse processing	20 (2 shifts/day, 5 days/week)
refuse/sludge disposal	24 (3 shifts/day, 7 days/week)

2) Maintenance Crew included in operating crew.

3) Training Program: On-the-job, plus instruction from equipment manufacturers.

4) Background of Management: Environmental engineering, especially wastewater treatment plant operation.

5) Safety Record

Lost Time Accidents Per Year: Not available.

Shredder Performance; Other Potentially Hazardous Equipment: No explosions in shredders; no other significant hazardous occurrences.

Other Comments: Only 100-200 hours of running time accrued to date.

6) Average or Typical Term of Employment: Operating period has been too brief to provide a meaningful value.

ENVIRONMENTAL CONSIDERATIONS

1) Permits (Local, State, Federal)

- To Construct: 1) City building permit

- To Operate: 2) NPDES permit for wastewater treatment plant
3) County solid waste disposal facility permit
4-6) Permits from Divisions of Minnesota Pollution Control Authority: Water Quality (same as NPDES), Air Quality (not yet issued), Solid Waste (conditional; two permits)

Starting Date for First Permit: 1972 (for wastewater plant)

Completion/Renewal Date for Last Permit: not yet obtained

2) Exhaust Gases

Source	Control Measure(s)
fluid-bed codisposal reactor	wet scrubber

Pollution Concentration Data - not yet sampled.

3) Wastewater

Source	Control Measure(s)	Receiving Body/System
wet scrubber	none prior to wastewater plant	wastewater treatment plant
ash handling		

4) Noise Measurements (Interior & Exterior) - informal measurements only; OSHA compliance assured.

5) Odor - comparable with other wastewater treatment facilities; refuse does not greatly increase odor problems.

6) Aesthetics - entire wastewater plant complex is attractive in appearance; refuse processing section is well integrated with remainder of facility.

APPENDIX B - BIBLIOGRAPHY

ANNOTATED BIBLIOGRAPHY

Consoer, Townsend & Associates, "Energy Study, Wastewater Collection and Treatment Facilities, WLSSD," December 1978.

This study identifies several sources of energy available to WLSSD from wastewater and solid waste. Chief among these is solid waste, followed by "internal energy" (heat energy present in wastewater). Assumptions made for this report are somewhat theoretical and perhaps oversimplified, but the results serve to identify several opportunities for energy conservation. In the solid waste processing plant, it is recommended that whenever possible, only one of the two processing lines be run; it is further recommended that particle size be maximized so that less energy is consumed during shredding.

Consoer, Townsend & Associates, "Preliminary Engineering Report, Solid Waste Disposal System," November 1974.

This early report identifies five candidate systems for the disposal of sewage sludge and solid waste. The five are rated according to several criteria such as system reliability, environmental effect, etc. A weighting and scoring scheme which results in a composite score for each candidate system is described. Detailed capital and O&M costs are given for each. Option 3, codisposal with fluidized bed reactors, is shown to have lowest cost and highest effectiveness score.

Western Lake Superior Sanitary District, "Solid Waste Management Plan, 1977 Revision," adopted February 13, 1978.

This plan begins with a series of statements of goals and objectives; most are quite general. Under the heading "Energy Conservation" is stated the goal to "maximize the use of available wastes as fuel." Several objectives, including the development of markets for excess prepared refuse, are listed. Supporting chapters describe the refuse and its source area, waste generation through 1975, disposal sites and practices, collection practices, disposal regulations, and a set of recommended policies for the District. An appendix contains the legislation which empowers WLSSD to control solid waste within its boundaries; the legislation also requires that this solid waste management plan be written, and that it address certain topics, listed above.

Evenson-Dodge, Inc., "Official Statement, General Obligation Bonds, Western Lake Superior Sanitary District," August 1, 1980.

This statement describes a $2.5 million general obligation bond issued by the District; a total of $753,000 from this issue is allocated to directly support the sludge and solid waste disposal facility. Of that amount, $438,000 is designated as "grant-related," i.e., to be matched with federal and state clean water grant funds. In fact, District staff report that use of these bond issue funds to support the codisposal project has not been necessary.

The bond is secured by a pledge of taxes which may be levied through the local governments served by the District.

The organization of the District, descriptions of key personnel, and financial information on cities and townships within the District are provided.

Minnesota Pollution Control Agency memoranda: 1) from Dave Zentner, MPCA Board Member; 2) from Agency staff to Board, dated February 24, 1976; and 3) from T.K. Scherkenbach to P.T. Beaton, MPCA Division of Water Quality.

These three memos present arguments for and against the use of EPA Clean Water construction grant money to support the WLSSD plant. Zentner feels that the Agency should assist the District and thus assume some of the risk of the project. The other two memos point out the need to use clean water funds in other parts of the state, and they suggest that if there is risk associated with this project, it would be more appropriate to seek R&D funding.

ARTICLES

"Clean Water" brochures with flow diagram
"Total Concept" brochure; "What is WLSSD?" brochure
Duluth Co-disposal Facility (ASME)

STUDIES

Preliminary Engineering Report, 1974 CT&A
Solid Waste Management Plan, 1977 revision WLSSD

PLANS/SPECIFICATIONS

Drawings from PRC/Consoer Townsend
Correspondence regarding specifications

PERMITS & REGULATIONS

Acid extraction ash leach procedure
Sludge handling permits
Compliance monitoring survey
NPDES permit and application
Air emissions correspondence
Permit to construct and operate
Landfill site report
WLSSD enabling legislation

PROSPECTUS

WLSSD, $2,500,000 bond issue

CONTRACTS

Ferrous metal purchase agreement
Change order
Correspondence

GRANT APPLICATIONS & GRANTS

Letter referencing innovative funding (and extension)
Correspondence regarding construction, grant and budget